CLAIMS

1. A waveguide element using a photonic crystal, the waveguide element comprising:

a core formed of a photonic crystal having a refractive index periodicity in at least two directions perpendicular to a propagation direction of an electromagnetic wave; and

a cladding arranged in contact with the core in order to confine the electromagnetic wave in the core;

wherein an incident side phase modulation portion is provided for allowing an electromagnetic wave that is coupled to a band on or near a Brillouin zone boundary in a photonic band structure in the core and propagates in the core to enter the core.

2. The waveguide element using a photonic crystal according to claim 1, wherein the incident side phase modulation portion allows the electromagnetic wave that entirely or mostly belongs to a single photonic band and propagates in the core to enter the core.

3. The waveguide element using a photonic crystal according to claim 1, wherein the photonic crystal serving as the core has no refractive index periodicity in the propagation direction of the electromagnetic wave.

4. The waveguide element using a photonic crystal according to claim 1, wherein the incident side phase modulation portion allows a substantially plane wave having an inclination angle with respect to an incident surface of the core to enter the core.

5. The waveguide element using a photonic crystal according to claim 1, wherein an incident surface of the core is inclined with respect to a plane

perpendicular to the propagation direction of the electromagnetic wave, and the incident side phase modulation portion allows a substantially plane wave to enter the core.

6. The waveguide element using a photonic crystal according to claim 1, wherein, at an incident surface of the core, the incident side phase modulation portion allows the electromagnetic wave subjected to a phase modulation periodically into an in–plane direction parallel with the incident surface to enter the core.

7. The waveguide element using a photonic crystal according to claim 6, wherein the incident side phase modulation portion allows a plurality of substantially plane waves to enter the incident surface of the core and allows the plurality of substantially plane waves to interfere with each other at the incident surface, thereby allowing the electromagnetic wave subjected to the phase modulation to enter the core.

8. The waveguide element using a photonic crystal according to claim 6, wherein the incident side phase modulation portion comprises

a phase grating disposed at a position close to or in contact with the incident surface of the core, and

an incident portion for allowing an electromagnetic wave to enter the phase grating.

9. The waveguide element using a photonic crystal according to claim 8, wherein the phase grating is formed as one piece with the core.

10. The waveguide element using a photonic crystal according to claim 1, further comprising an exit side phase modulation portion disposed at a position close to or in contact with an exit surface of the core from which an

electromagnetic wave exits,

wherein the exit side phase modulation portion converts the electromagnetic wave that exits from the core into a substantially plane wave.

11. The waveguide element using a photonic crystal according to claim 10, wherein the exit side phase modulation portion is formed as one piece with the core.

12. The waveguide element using a photonic crystal according to claim 10, wherein the exit side phase modulation portion has an identical structure with the incident side phase modulation portion and is disposed such that a positional relationship between incident and exit ends of the exit side phase modulation portion is reversed from that of the incident side phase modulation portion.

13. The waveguide element using a photonic crystal according to claim 1, wherein the cladding is a photonic crystal having a refractive index periodicity in at least one direction perpendicular to the propagation direction of the electromagnetic wave propagating in the core.

14. The waveguide element according to claim 13, wherein the cladding is the photonic crystal having no refractive index periodicity in the propagation direction of the electromagnetic wave propagating in the core.

15. The waveguide element using a photonic crystal according to claim 1, wherein a waveguide portion constituted by the core and the cladding has a structure in which a plurality of parallel grooves are formed in a multilayered body having a plurality of periods, and

the grooves are perpendicular to each layer in the multilayered body

and run along the propagation direction of the electromagnetic wave.

16. The waveguide element using a photonic crystal according to claim 1, wherein the core is a homogeneous material in which a plurality of cavities extending along the propagation direction of the electromagnetic wave are formed, and

the cavities are arranged so as to have a constant period in a plane perpendicular to the propagation direction of the electromagnetic wave.

17. The waveguide element using a photonic crystal according to claim 16, wherein all or some of the plurality of cavities are filled with a fluid material.

18. The waveguide element using a photonic crystal according to claim 16, wherein all or some of the plurality of cavities are filled with an active material having an optical non–linear effect.

19. The waveguide element using a photonic crystal according to claim 16, wherein the core has a fiber shape with a substantially circular cross–section.